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Canadian Strategic Highway Research Program:

Progress Report 1987/88

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Transportation Development Centre

Transport Canada

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by

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Roads and Transportation Association of Canada

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17. Abstract

The progress of the Canadian Strategic Highway Research Program is reviewed during the first year of its five-year planned life. The organizational structure developed to direct and administer the research is documented, the scope and budget of the program and its components are summarized and the linkages with the U.S. Strategic Highway Research Program are reviewed. The terms of reference for research projects developed during the year are documented, and the progress achieved by the five projects launched during the year is summarized. The prospectus and workplan for the second and subsequent years of the program is included.

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17. Résumé

Ce document fait le point sur l'avancement du Programme stratégique de recherche routière du Canada au cours de la première des cinq années que celui-ci doit durer. Il présente la structure organisationnelle mise en place pour assurer la direction et l'administration des travaux de recherche, fournit les grandes lignes de la portée et du budget du programme et de ses éléments, et examine les liens de celui-ci avec le programme mené en parallèle aux États-Unis. L'énoncé des travaux de différents projets de recherche définis dans cette première année, ainsi que l'état d'avancement des cinq projets lancés en cours d'année sont également présentés. Les prévisions et le plan d'action de la deuxième année du programme et des suivantes sont inclus.

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Canada

Executive Summary

As the Canadian Strategic Highway Research Program (C-SHRP) ends its first full year of operation, the pace of activity is rapidly increasing.

During the first half of the year efforts were directed toward establishing a working committee structure, setting priorities, and defining research projects consistent with the needs of the sponsoring agencies. This process was carried out with careful review and monitoring of developments within the U.S. program (SHRP) to ensure overlaps and redundancies were avoided.

The latter half of the year was spent in developing program areas and initiating the first series of projects seen as complementary to the coverage of the U.S. program.

SHRP Cooperation

While there have been a relatively large number of projects launched under SHRP since the summer of 1987, the area where direct Canadian involvement is expected, Long Term Pavement Performance (LTPP), has been slow to develop. Canadian jurisdictions have collectively offered over 100 sites to the U.S. as candidates for the program: however, decisions have not yet been rendered on which will be included. At last estimate, it was expected that about 35 Canadian sites would be selected for the long term performance monitoring effort.

The first Canadian visiting researcher to SHRP, Mr. Floyd Derkat from Alberta Transportation, has been in Washington since June 1987, and has proven invaluable to both the SHRP and C-SHRP organizations in a liaison capacity. The next Visiting Researcher will be Mr. Andy Horosko from Saskatchewan Highways and Transportation, who will assume this responsibility from August this year until July 1989. He will be followed by Mr. Guy Dorè from Transports Québec for 1989/90.

C-SHRP Complementary Program

While 1987 saw a great deal of activity launched in the C-SHRP Complementary Program, the key highlights are as follows.

To date three major contracts have been awarded for complementary projects:

1. Corrective Measures for Surface Defects in Flexible Pavements:
awarded to Pavement Management Systems Ltd. (value $ 350,000)

2. Quantification of the Service Life of Existing Canadian Methods of Rehabilitating Concrete Decks, Beams, Piers and Abutments:
awarded to Trow Inc. Consulting Engineers (value $ 300,000)

3. Removal of Hazards due to Ravelling of Granular Shoulder Material:
awarded to John Emery Geotechnical Engineering Limited (value $ 130,000)

In addition, work has been underway since the summer of 1987 in developing a long term pavement performance program based on Canadian needs which would serve to complement the work to be carried out under SHRP. The services of the Alberta Research Council were retained to develop this program and a final report is expected in May 1988, with a view to launching this effort in the summer of 1988. The program will monitor the effectiveness of different rehabilitation techniques under Canadian environmental and traffic conditions. It is noteworthy that rehabilitation effectiveness was cited by all jurisdictions as the highest research priority to be addressed, reflecting the current state of the maturing highway system in Canada.

The Alberta Research Council is also developing a proposal to conduct further studies at the fourteen instrumented pavement sites established for the Vehicle Weights and Dimensions Study. Testing is expected to begin in the summer of 1988 to examine pavement loading response influences due to aging, as well as variables such as extraordinarily high loads, tire pressure, spring thaw conditions, and differing truck axle configurations.

A study has also been launched to survey current Canadian practice with the use of bituminous surface treatments, to identify areas where research efforts are required, and to design research program options capable of addressing these needs. Mr. John Scott, formerly of Saskatchewan Highways and Transportation, has been retained to carry out this task.

A series of other projects is currently under development and will be considered for initiation later this year by the Technical Steering Committee.

In summary, fiscal year 1988/89 will see a great deal of activity taking place under the C-SHRP, with an expected $ 1.1 million to be spent on the research investigations.

C-SHRP Administration

A reorganization within the Newfoundland government resulted in the departure of Mr. Lew White as the Chairman of the C-SHRP Executive Committee. Mr. White's leadership and contribution to the program in its developmental stages, and through the first year of operation, were instrumental in seeing the establishment and launch of a viable administrative structure and program framework.

Mr. Lou Centa, Deputy Minister of the Nova Scotia Department of Highways and Transportation, assumed the Chairmanship of the Executive Committee in February 1988.

Mr. Guy Doré joined C-SHRP in late 1987 in the capacity of Visiting Researcher, on loan from Transports Québec. Mr. Doré will remain with the program until June 1989 with responsibilities for developing and overseeing various aspects of the pavement and highway operations research investigations.

Applications for the position of National Coordinator were solicited in the fall of 1987. Mr. Gregory Williams was selected to assume this responsibility and will be joining the program in May 1988.

SOMMAIRE

Au terme de la première année complète d'existence du Programme stratégique de recherche routière du Canada (C-SHRP), le rythme des activités augmente rapidement.

Dans la première moitié de l'année, les efforts ont porté sur l'établissement de la structure des comités de travail, la définition de l'ordre des priorités et l'élaboration de projets de recherche cadrant avec les besoins des organismes parrains. Pour éviter les chevauchements et doubles emplois, les responsables de cette phase préliminaire ont pris soin d'examiner le programme parallèle (SHRP) amorcé aux États-Unis et d'en suivre l'évolution.

La deuxième moitié de l'année a été consacrée à la définition des domaines de recherche et à la mise en route d'une première série de travaux jugés complémentaires aux actions prévues dans le programme américain.

Coopération SHRP/C-SHRP

Bien qu'un nombre relativement important de travaux aient été lancés du côté américain depuis l'été 1987, le secteur où une participation directe du Canada est prévue, soit la tenue a long terme des chaussées, a été lent à se mettre en branle. Les autorités canadiennes ont proposé au total plus de 100 sites de suivi/contrôle pour les fins du programme américain dans ce secteur, mais le choix définitif des sites n'a pas encore été arrêté. Selon la plus récente estimation, il semble que quelque 35 sites canadiens seront retenus dans le cadre du programme de suivi de la tenue à long terme des chaussées.

Le premier chercheur canadien détaché auprès du SHRP, M. Floyd Derkat, du ministère albertain des Transports, est en poste à Washington depuis juin 1987; il s'est avéré un agent de liaison extrêmement apprécié par les deux organisations concernées. Le prochain, qui doit occuper cette fonction entre août 1988 et juillet 1989, sera M. Andy Horosko du ministère de la Voirie et des Transports de la Saskatchewan. Suivra M. Guy Doré de Transports Québec, en 1989-1990.

Programme complémentaire du C-SHRP

Voici les faits marquants de 1987 parmi les tres nombreuses activités lancées en vertu du programme complémentaire de 1987. Jusqu'à présent, trois grands marchés d'études ont été accordés:

1. Correction des défauts de surface des chaussées souples, Pavement Management Systems Ltd. (350 000 $);

2. Détermination de la durée utile des méthodes canadiennes actuelles de remise en état de tabliers, poutres, colonnes et culées en béton, Trow Inc. Consulting Engineers (300 000 $);

3. Élimination des dangers résultant de l'érosion des accotements à revêtement granulaire, John Emery Geotechnical Engineering Limited (130 000 $).

Par ailleurs, l'élaboration d'un programme de suivi/contrôle de la tenue à long terme des chaussées, se poursuit depuis l'été 1987, axé sur les besoins canadiens de façon à compléter les travaux corollaires du SHRP. Cette tâche, confiée à l'Alberta Research Council, devrait déboucher sur un rapport final en mai 1988 et sur le début effectif du programme au cours de l'été 1988. Il s'agira de contrôler l'efficacité de différentes techniques de remise en état dans les conditions environnementales et de circulation routière propres au Canada. Il n'est pas inutile de rappeler que cette question a été placée au premier rang des priorités de recherche par tous les paliers du gouvernement concernés, un fait indicatif de l'état actuel du réseau routier vieillissant du Canada.

L'Alberta Research Council est également en train d'élaborer une proposition visant de nouvelles études à faire aux 14 sites d'essais instrumentés pour les fins de l'étude sur la réglementation des poids et dimensions des véhicules de transport routier. Les essais en question devraient commencer vers l'été 1988; ils visent à déterminer l'influence du vieillissement sur la réaction des chaussées aux efforts, sans oublier d'autres variables comme les surcharges exceptionnelles, la pression des pneus, les cycles printaniers de gel-dégel et la gamme des configurations d'essieux des véhicules de transport routier.

Une autre étude a été lancée dans le domaine des traitements des chaussées bitumineuses. Elle vise trois objectifs: répertorier les pratiques canadiennes dans ce domaine, identifier les secteurs où faire porter les efforts de recherche et définir des programmes de recherche susceptibles de répondre aux besoins dégagés. Cette tâche a été confiée à M. John Scott, anciennement du ministère de la Voirie et des Transports de la Saskatchewan. D'autres projets sont en cours de définition, le Comité directeur technique devant se prononcer sur leur lancement plus tard cette année.

En résumé, le programme C-SHRP tournera à fond de train en 1988-1989, le niveau des dépenses de recherche devant atteindre 1,1 million de dollars.

Administration du C-SHRP

La réorganisation au sein de l'appareil gouvernmental de Terre-Neuve a entraîné le remplacement de M. Lou White, au poste de président du comité exécutif du C-SHRP. La mise en place d'une solide structure administrative et d'un cadre de travail viable est due en partie au leadership et aux efforts de M. White à l'étape de la définition du programme et durant la première année de sa mise en oeuvre.

M. Lou Senta, sous-ministre de la Voirie et des Transports de la Nouvelle-Écosse a assumé la charge de président du comité exécutif en février 1988.

M. Guy Doré, de Transports Québec, s'est joint à l'équipe du C-SHRP vers la fin de 1987 à titre de chercheur délégué. Il demeurera en poste jusqu'en juin 1989, sa fonction étant de mettre au point et de surveiller divers aspects des recherches concernant les chaussées et opérations routières.

À la suite d'un appel de candidatures lancé à l'automne 1987, le poste de coordonnateur national a été confié à M. Gregory Williams qui doit entrer en fonction en mai 1988.

Table Of Contents:

Executive Summary	iii
Sommaire	vii
1. Introduction	1
2. Program Overview	3
a. Adminstrative Structure	3
b. Program Scope and Budget	5
3. U.S. Strategic Highway Research Program: C-SHRP Cooperation	7
a. Monitoring	7
b. Visiting Researcher Program	10
c. Visiting Researcher Report	10
d. Integral Research Program	11
4. Complementary Program	13
a. Program Overview	13
b. Development of Project Terms of Reference	14
c. Project Status Reports	15
d. Complementary Program Development	16
5. Technology Transfer	17
a. Program Overview	17
b. Status	17
6. 1988/89 Prospectus and Workplan	19
Appendix A: C-SHRP Committee Membership	23
Appendix B: Completed Project Terms of Reference	39

1. Introduction

The Canadian Strategic Highway Research Program was launched in 1987 with the objective of participating in, and conducting research which is complementary to, the U.S. Strategic Highway Research Program (SHRP). As an extension of SHRP, C-SHRP shares the goals and objectives of the U.S. initiative which are intended to "stimulate rapid development of highway technology in the areas of:

asphalt,
pavement performance,
maintenance cost-effectiveness,
protection of concrete bridge components,
cement and concrete in highway pavements and bridges, and
chemical control of snow and ice on highways".

The nature of SHRP is evident in the criteria adopted by the program for project selection:

- Will the research yield big payoffs?
- Is the research area currently neglected?
- Will the project deal with important research previously hampered by institutional or organizational barriers?
- Can the research findings be used?
- Does the research require a large scale effort?
- Does the research require an integrated or national approach?
- Does the research respond to new and potential changes in national policy?
- Does the research use or respond to other technological changes?
- Will the research affect safety or the environment significantly?

The C-SHRP initiative is being undertaken with the following program thrusts:

a. Monitoring:

- collecting and disseminating information on both the U.S. and Canadian research activities and identifying Canadian opportunities for implementation of practical solutions.

b. Technology Transfer:

- assisting Canadian jurisdictions in recognizing the implications of SHRP and C-SHRP findings for their own design, construction and quality control procedures, and updating the C-SHRP plan itself in light of new information.

c. Integrated Research Program:

- incorporating Canadian sites and facilities into the American research program to assist both countries in extending the relevance and applicability of the research.

d. Complementary Research Program:

- undertaking research in Canada to seek solutions to uniquely Canadian problems, complementary to but not duplicating problems addressed by SHRP.

2. Program Overview

a. Administrative Structure

The Canadian Strategic Highway Research Program is sponsored jointly by the ten provinces, two territories and the federal government. A budget of $ 5 million has been allocated by the sponsors for the five year program, to achieve the following objectives:

a. To participate directly in the U.S. Strategic Highway Research Program (SHRP)

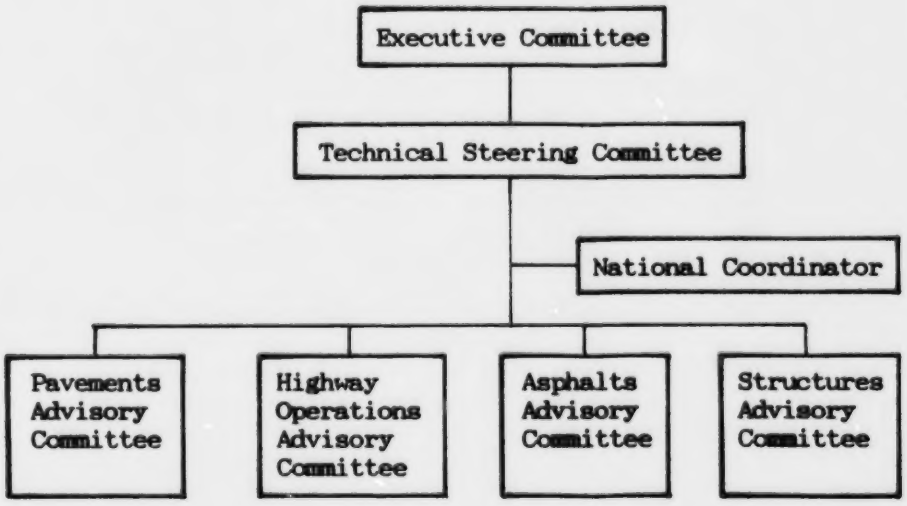
b. To monitor the developments of the SHRP program as they affect the planning for the C-SHRP complementary program

c. To undertake a program of research seen to be complementary to the U.S. program to address specific or uniquely Canadian highway research needs

d. To transfer to the Canadian highway engineering community research findings, recommended practice, and new technologies emerging from both the SHRP and C-SHRP initiatives.

To accomplish these objectives an administrative structure has been established to provide mechanisms to advise, develop, manage and direct the program.

Figure 1: Organization Overview



The *Executive Committee* is responsible for the overall direction of the program, establishment of all policies and procedures, and approval of all expenditures in excess of $ 25,000. It reports to the Board of Directors of the Roads and Transportation Association of Canada.

The *Technical Steering Committee* is comprised of one representative of each of the sponsoring agencies (the federal, provincial and territorial governments) and is responsible for adminstrative and technical control of the program. Non-voting members of the committee include the Visiting Researcher to SHRP, the Canadian representatives to the SHRP Advisory Committees and the National Coordinator.

The *Advisory Committees* are comprised of individuals with recognised expertise in their field, and are responsible for providing technical advice and guidance on the specific research initiatives planned, proposed or being carried out in their discipline. The Advisory Committees are chaired by the Canadian representative to the respective SHRP Advisory Committees.

The *National Coordinator* is a full time staff member with the Roads and Transportation Association of Canada and is responsible for overall coordination and management of the program. He reports to the Technical Steering Committee.

The members of the committees described above are listed in Appendix A.

b. Program Scope and Budget

The scope and content of the C-SHRP program, as originally approved, can be broken down by activity area as follows:

Activity Area	Breakdown	Budget $5,000,000.00
PROGRAM ADMINISTRATION		**$895,000.00**
Coordinator	$455,000.00	
Newsletter	$90,000.00	
Information Mgt System	$240,000.00	
Seminars	$100,000.00	
Program Review	$10,000.00	
SHRP - INTEGRAL PROGRAM		**$540,000.00**
Test Site Support	$90,000.00	
Visiting Researcher	$450,000.00	
SHRP - TECHNOLOGY TRANSFER		**$500,000.00**
Pavements	$125,000.00	
Structures	$125,000.00	
Highway Operations	$125,000.00	
Asphalts	$125,000.00	
COMPLEMENTARY PROGRAM		**$3,065,000.00**
Pavements:	$1,471,000.00	
VW&D Test Sites	$410,000.00	
Canadian LTPP	$675,000.00	
Bituminous Surface Treat	$308,000.00	
Automated Distress Measur	$78,000.00	
Asphalts:	$314,000.00	
A,B & C Asphalts - Lab	$164,000.00	
A,B & C Asphalts - Field	$150,000.00	
Highway Operations:	$650,000.00	
Surface Defects	$350,000.00	
Shoulder Ravelling	$130,000.00	
Snowdrifting	$80,000.00	
Snowdrifting - Expert Sys	$60,000.00	
Deicing Chemicals	$30,000.00	
Structures:	$630,000.00	
Structure Repairs	$300,000.00	
Bridge Evaluation	$120,000.00	
Fibre Shotcrete	$150,000.00	
Corrosion Resist Repairs	$ 60,000.00	

3. U.S. Strategic Highway Research Program: C-SHRP Cooperation

The involvement of C-SHRP with the U.S. SHRP program extends to three levels:

a. Monitoring: Active participation by Canadians in the SHRP advisory, management and operational committee structure

b. Visiting Researcher Program: Placement of a Canadian researcher within the SHRP offices to assist in the design, operation and management of SHRP.

c. Integral Research Program: Direct participation by Canadian provinces in research programs being carried out under the sponsorship of SHRP.

a. Monitoring

Canada has been fortunate in having had the opportunity to participate in the development of SHRP since the initial discussions of the program began in 1984. A close relationship has been maintained since that time, and representatives of Canadian highway agencies have been participants in virtually all aspects of the planning, advisory and steering activities of SHRP since its inception.

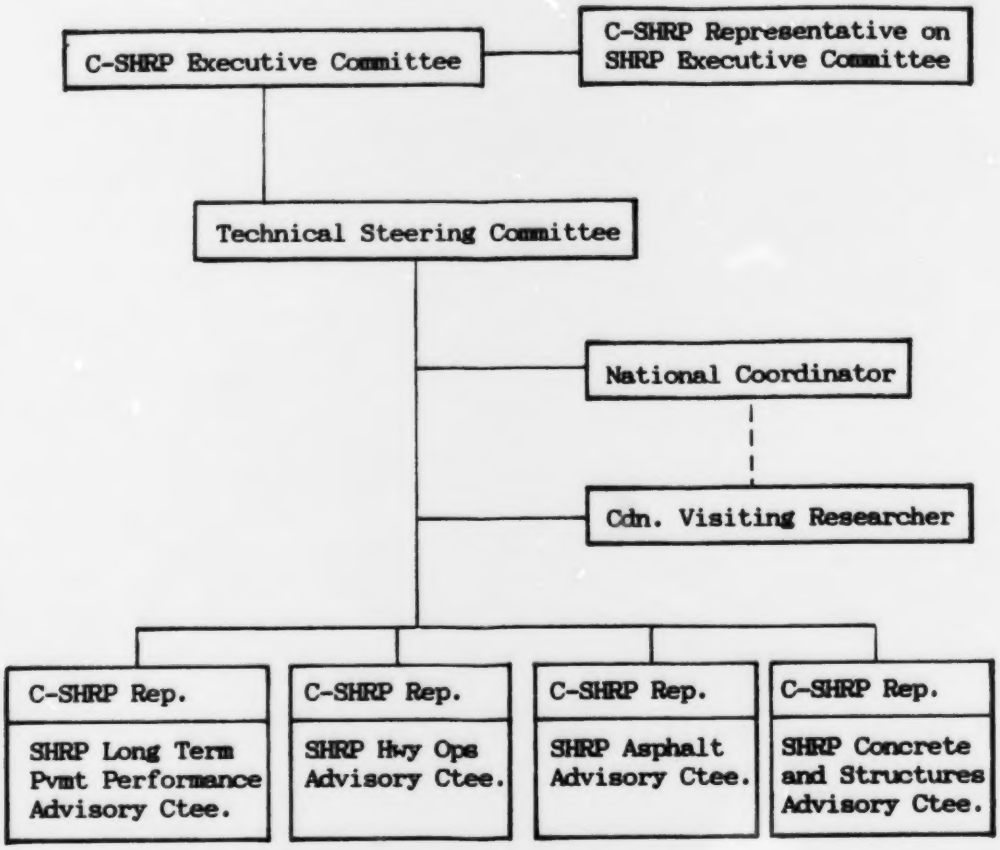
While many countries are actively involved with the SHRP program, Canada is the only other country represented on the SHRP Executive Committee, a responsibility held by Mr. Boris Hryhorczuk, Deputy Minister, Manitoba Highways and Transportation.

C-SHRP also has representatives on each of the four Advisory Committees of SHRP as follows:

Long Term Pavement Performance:	Dr. J.T. Christison, Alberta Research Council
Asphalts:	Mr. R. Langlois, Ministere des Transports du Quebec
Concrete and Structures:	Dr. D. Manning, Ontario Ministry of Transport
Highway Operations:	Mr. K. Hicks, New Brunswick Dept. of Transportation

These individuals are responsible for bringing the Canadian perspective to the SHRP program planning and advisory activities, for reporting to the C-SHRP Technical Steering Committee on SHRP developments and initiatives, and for chairing the corresponding C-SHRP Advisory Committees. In 1987, each of these individuals renewed their term of membership on the SHRP Advisory Committees for a further two years.

Figure 2: SHRP Liason & Monitoring: Organization Overview



As SHRP projects have been launched, further Canadian participation has been solicited to serve on Expert Task Groups, whose reponsibility is to evaluate proposals received from contract agencies for the program. The Expert Task Groups are formed for this purpose alone, and hence require only short term commitments of time from participants.

The level of Canadian involvement described above, coupled with the role and responsibilities of the Canadian Visiting Researcher to SHRP, have proven to be invaluable and effective means of monitoring the development of SHRP. With this level of collaboration, it has been possible to plan the research program to be carried out under C-SHRP with assurances that redundancies and overlaps between the programs are minimized.

b. Visiting Researcher Program

Under SHRP, procedures have been established to permit close cooperation between the program and other countries, including the provision to send special billets to serve on the SHRP staff. While fifteen countries have designated National Coordinators for SHRP, to date only Canada and the Nordic Countries have loaned staff in place at SHRP.

In early 1987, applications were solicited from across Canada for the position of Visiting Researcher to SHRP. Following a review and selection process, Mr. Floyd Derkat from Alberta Transportation was chosen to serve as the first Visiting Researcher to SHRP. The nomination of Mr. Derkat was accepted by SHRP, and he assumed his duties with the program in June of 1987. Mr. Derkat will remain with the SHRP offices until August of 1988 when he will be replaced by Mr. Andy Horosko of Saskatchewan Highways and Transportation.

c. Visiting Researcher Report

I commenced working at the SHRP offices in Washington, D.C. as the first loaned person from Canada. International loaned staff at the SHRP offices as of April 1, 1988 will include respresentatives of the United Kingdom, Australia, Ireland and Denmark (Nordic countries).

Initial contributions of loaned staff in the summer of 1987 were to carry out the individual state visits to broaden the exposure of SHRP and solicit additional test sections. Later in the year loaned staff assisted in the preparation of Requests for Proposals, evaluating proposals, organizing Expert Task Groups, carrying out numerous investigative projects and state telephone surveys, and preparing materials for the numerous committee meetings.

In this early stage, SHRP is receiving the major benefit from loaned staff with their varied backgrounds and fields of expertise. As the research projects begin to yield test information, the loaned staff sponsoring countries should begin receiving the benefits from this tremendously large research project that all countries can relate to. SHRP has awarded approximately twenty contracts in the four technical research areas, as well as providing funding for several SHRP-IDEA unsolicited proposals. The contract research is now just beginning which does of course include many Canadian sites to be monitored. The phase beginning in 1988 will now also expose SHRP to the general motoring public, who will also be contributing to SHRP by enduring the minor inconveniences associated with the field monitoring.

Floyd Derkat
C-SHRP Visiting Researcher

d. Integral Research Program:

At the outset of SHRP, Canada was invited to participate directly in elements of the research investigations. Of particular interest to Canada has been the Long Term Pavement Performance program planned under SHRP. The experimental design for this program calls for the ongoing monitoring of test sites in two categories; General Pavement Projects and Specific Pavement Projects.

Under the General Pavement Projects experiment, the performance of over 1000 test sites will be monitored, chosen to provide statistically sound insight to the influence on performance of a wide range of variables including construction type, soil conditions, environment, traffic and so on. Criteria to be used in selectng sites for the program were provided to C-SHRP in 1986, and as a result, Canadian highway agencies have offered over 100 sites for consideration by SHRP in conducting the experiment. While the final site selection decisions have not yet been taken, it is expected that about 35 Canadian sites will be included in the General Pavement Projects experiment.

Canada is also interested in the Specific Pavement Projects experiment, and will follow the development of this program closely in 1988/89. Current estimates from SHRP call for completion of the experimental design and implementation by the end of 1988. The form and degree of Canadian participation in this program will be decided as the planning progresses.

4. Complementary Program

a. Program Overview

The C-SHRP Complementary Program is the vehicle through which research will be carried out in Canada to:

- extend the coverage of the SHRP investigations to better address uniquely Canadian conditions

- examine research areas which are of pressing concern to Canadian agencies, but which will not be examined in SHRP

- to develop Canadian technologies or capabilities which promise high returns, but would not be explored under SHRP

A listing of nineteen candidate projects for the C-SHRP Complementary Program was developed through a widely attended workshop held in Winnipeg in 1986. At the time, these projects were deemed to hold high priority and did not appear to be addressed in SHRP.

Once the structure for C-SHRP was established, the Advisory Committees were asked to evaluate the candidate projects with a view to selecting those which had retained high priority, and which could be acted upon without fear of overlap with the SHRP activities. The original listing of candidate projects was as follows:

Project	Title
A-1	Further Monitoring of Weights and Dimensions Test Sites
A-2	Pavement Performance Evaluation of A,B,C Quality Asphalts
A-3	Field Verification of A,B,C, Quality Asphalts
B-1	Canadian Long Term Pavement Performance
B-2	Design Method for Bituminous Surface Treatments
B-3	Effects of Heavy Loads on Bituminous Surface Treatments
C-1	Removal of Hazards due to Ravelling of Shoulder Material
C-2	Demonstration of Technology to Automate the Measurement of Pavement Distress
C-3	Corrective Measures for Ruts in Flexible Pavements
C-4	Improved Materials and Equipment for Pavement Surface Repairs and Crack Filling
D-1	To Quantify the Service Life of Existing Canadian Methods of Protection and Rehabilitation of Decks, Beams, Piers and Abutments
D-2	Economic Feasibility of Making Corrosion Resistant Reinforcing Steel
D-3	Synthesis of Research on Load Carrying Capacity of Bridges into Evaluation Guidelines
E-1	Investigation and Documentation of the Benefits of Fibre Shotcrete and Development of Standard Procedures for its Application
E-2	Investigation of the Mechanisms of, and Development of Development of Defense Against, Alkali-Carbonate and Other Reactivity Problems
E-3	Development of Premium Cement
F-1	Corrective Measures for Highway Snowdrifting Problems
F-2	Expert System to Combine Snowdrifting Control Expertise with Geometric Design Constraints
F-3	Immobilizing Deicing Chemicals on Roadway Surfaces

b. Development of Project Terms of Reference

Following scrutiny by the Advisory Committees, seven projects were selected for development of terms of reference:

1. Further Monitoring of Vehicle Weights and Dimensions Test Sites:
   (Project A-1)

2. Canadian Long Term Pavement Performance Program:
   (Project B-1)

3. Bituminous Surface Treatments:
   (Projects B-2 and B-3 combined)

4. Correction of Surface Defects in Flexible Pavements:
   (Projects C-3 and C-4 combined)

5. Removal of Hazards due to Ravelling of Granular Shoulder Material:
   (Project C-1)

6. To Quantify the Service Life of Existing Canadian Methods of Rehabilitation of Decks, Beams, Piers and Abutments:
   (Project D-1)

7. Performance Correlation of Quality Paving Asphalts:
   (Projects A-2 and A-3 combined)

In addition, Transport Canada proceeded with the launch of Project F-1: Corrective Measures for Highway Snowdrifting Problems in 1986, in anticipation of subsequent financial participation by C-SHRP. This project has been reviewed by the Highway Operations Advisory Committee, and C-SHRP participation has been deferred until a review of the final report from the consultant is completed.

c. Project Status Reports:

Complementary Project 1: Further Monitoring of Vehicle Weights and Dimensions Test Sites

Status:

The terms of reference was approved by the Technical Steering Committee in the summer of 1987. Due to their unique experience wih the pavement instrumentation at these sites, the Alberta Research Council was asked to prepare a proposal to undertake this project. The proposal will be reviewed in May of 1988 with a view to launching the project in the summer of 1988.

Complementary Project 2: Canadian Long Term Pavement Performance Program

Status:

The terms of reference was approved by the Technical Steering Committee in the summer of 1987. Dr. Tom Christison, of the Alberta Research Council, and Mr. Albert Stevens, of the University of New Brunswick, were commissioned to undertake a survey of research needs and priorities in this area and to develop and propose a research investigation which would address these needs. An interim report was presented to the Technical Steering Committee in January 1988, and a completed research plan and procedure will be presented in May of this year.

Complementary Project 3: Design Methods for Bituminous Surface Treatments

Status:

Prior to initiating specific research projects in this area, the Technical Steering Committee chose to examine and inventory current Canadian practice with the use of BST's and, through a survey, identify research needs and priorities. This work was carried out by Mr. John Scott, formerly with Saskatchewan Highways and Transportation, in accordance with the terms of reference which appears in Appendix B. The final report,including identified research needs and priorities and research program options, will be presented to the Technical Steering Committee in May.

Complementary Project 4: Correction of Surface Defects in Flexible Pavements

Status:

The terms of reference was approved by the Technical Steering Committee in the fall of 1987. A request for proposals was issued to the consulting community, and following an evaluation procedure, the firm of Pavement Management Systems Ltd. was retained to undertake this work. Work began on this project in March, with a major interim report to be delivered in September.

Complementary Project 5: Removal of Hazards due to Ravelling of Granular Shoulder Material

Status:

The terms of reference was approved by the Technical Steering Committee in the fall of 1987. A request for proposals was issued to the consulting community, and following an evaluation procedure, the firm of John Emery Geotechnical Engineering Limited was retained to undertake this work. Work began on this project in February, with the delivery of a major interim technical report expected in September.

Complementary Project 6: To Quantify the Service Life of Existing Canadian Methods of Rehabilitation of Decks, Beams, Piers and Abutments

Status:

The terms of reference was approved by the Technical Steering Committee in the fall of 1987. A request for proposals was issued to the consulting community, and following an evaluation procedure, the firm of Trow Engineering Ltd. was retained to undertake this work. Work began on this project in February, with a major interim technical report expected in September.

Complementary Project 7: Performance Correlation of Quality Paving Asphalts

Status:

Further development of the terms of reference for this project was halted in late 1987 due to concerns for possible overlap with the SHRP asphalts investigations. Consideration of this project will resume once the SHRP project definitions are completed.

d. Complementary Program Development

The list of candidate projects for the C-SHRP Complementary program will be reviewed regularly over the life of the study to consider the impacts of changing research priorities or new developments. It is likely that several of the original project proposals will not be pursued for this reason, and will be replaced by new, higher priority research investigations.

In this regard, the project originally designated C-2: Demonstration of Technology to Automate the Measurement of Pavement Distress has been deleted. In its place, a terms of reference is under development to descibe a project to investigate the feasibility of developing an automated pavement cracking recognition system.

In collaboration with SHRP, C-SHRP is participating in a survey of the asphalt refineries to determine the types and range of product being offered to the highway construction industry. The survey is being conducted by the Asphalts Institute, and promises to provide a useful reference for the identification of uniquely Canadian research needs in the asphalts area.

5. Technology Transfer

a. Program Overview

The transfer of technology, findings and conclusions from the research program to the practitioner is viewed as one of the highest priorities of the program.

The original planning for C-SHRP included consideration of the need to retain experts in the four principal research areas of SHRP and C-SHRP to interpret interim findings, screen them for potential benefit to Canadian jurisdictions and relay them in a format conducive to understanding and implementation by practitioners. The planning and budget for C-SHRP allocated $ 500,000 or 10% of the program's resources to technology transfer.

In addition to the above mechanism, a condition applied to each of the contracts awarded under C-SHRP requires the researcher to prepare and conduct one or more seminars on the conduct and findings of his investigation. The Technical Steering Committee will be employing this mechanism through the course of the program to ensure the Canadian highway engineering community is aware of the research activities and is provided insight to, and guidance on, the findings as they become known.

b. Status

As both SHRP and C-SHRP research programs are, at present, in the early stages, this aspect of the technology transfer program has not yet been initiated. The Technical Steering Committee will be developing detailed plans for the transfer and implementation of research findings, both at the project and program level during the second year of operation.

6. 1988/89 Prospectus and Workplan

The overall schedule for the C-SHRP program is depicted in the figure which follows.

The program administration activities are expected to continue to increase in 1988 as the SHRP and C-SHRP research projects begin field testing activities. The newsletter will continue to be published quarterly during the year, as the principal means of disseminating information to the community at large. The second seminar on the SHRP and C-SHRP programs will be held during the RTAC Annual Conference in Halifax, Nova Scotia in September. Finally, in early 1988 it is expected that an Information Management System will be established within C-SHRP to assemble, store and transmit data from the test programs, to track the progress of all SHRP and C-SHRP investigations and to provide access to information on the program to the sponsoring agencies.

It is expected that the SHRP Long Term Pavement Performance investigations will begin in the summer of 1988, with Canadian participation. Inclusion in this program will require provinces which host test sites to assume responsibility for regular ongoing data collection activities at their sites for transmission to the master databases at SHRP and C-SHRP. Elements of the data collection requirements at these sites will be undertaken by contractors to SHRP on a regular basis.

The Canadian visiting researcher position with SHRP will change in August, with Floyd Derkat from Alberta Transportation completing his term, and Andy Horosko from Saskatchewan Highways and Transportation assuming this position for one year.

The technology transfer program will be planned and initiated later in the year, as interim findings begin to arise in SHRP and C-SHRP projects.

Three complementary projects were launched in 1987 and will proceed through 1988 and 1989. These include:

- Correction of Surface Defects in Flexible Pavements
- To Quantify the Service Life of Existing Canadian Methods of Rehabilitation of Decks, Beams, Piers and Abutments
- Removal of Hazards Due to Ravelling of Granular Shoulder Material

Two more projects will be initiated in the late spring of 1988:

- the Canadian Long Term Pavement Performance Program
- Further Monitoring of the Vehicle Weights and Dimensions Test Sites

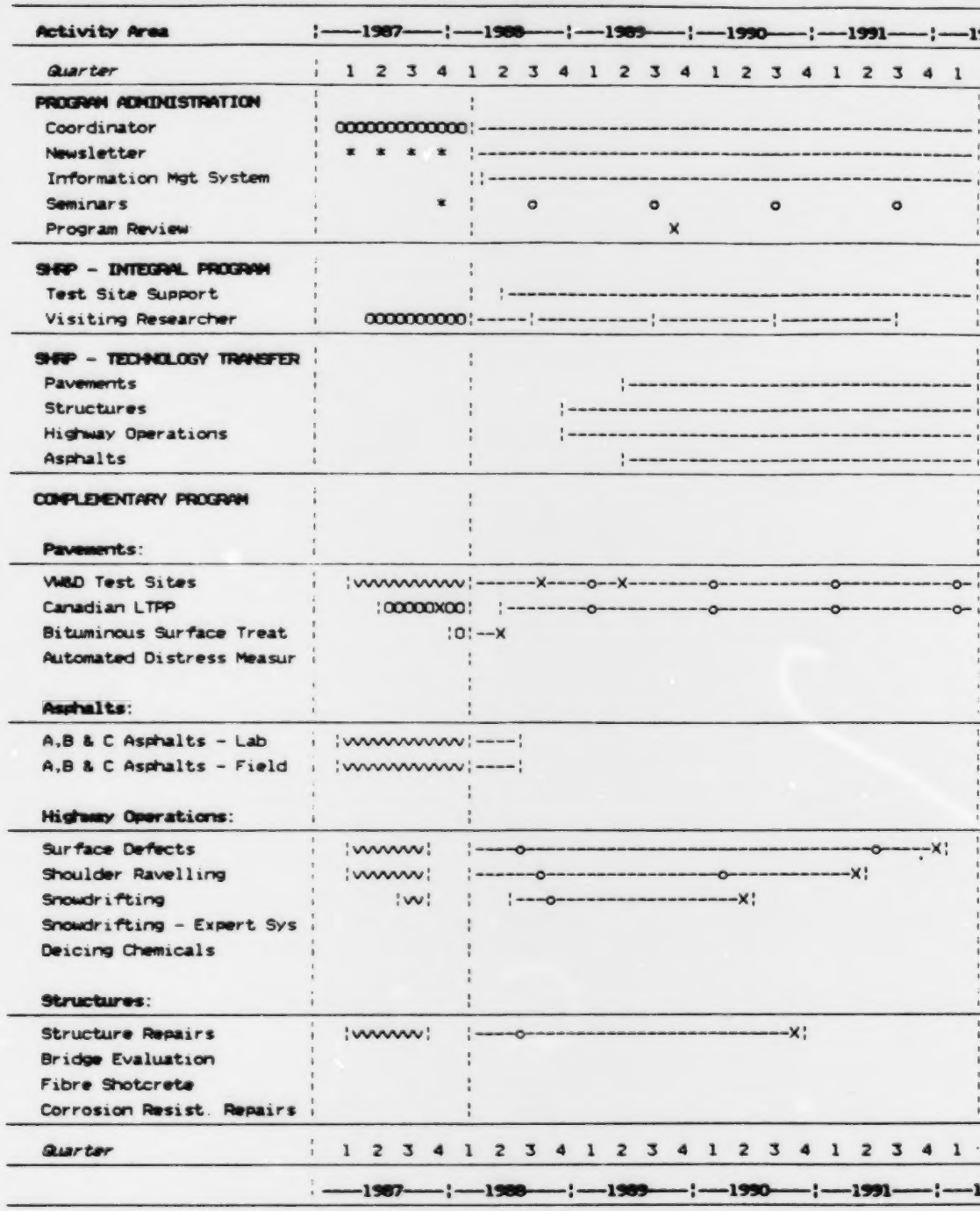
The Technical Steering Committee will be reviewing the research program proposals developed in the area of Bituminous Surface Treatments, and may consider the launch of one or more projects during the year.

The Complementary Program will be critically reviewed during the year, to identify areas where terms of reference should be developed for other candidate research projects. This process requires continual monitoring of developments within SHRP, and review of new or emerging research priorities within the Canadian highway engineering community.

C-SHRP RESEARCH PROGRAM : STATUS OVERVIEW

Activity Area	Status
PROGRAM ADMINISTRATION	
Coordinator	In place May 1, 1988
Newsletter	Ongoing (quarterly)
Information Mgt System	Under development
Seminars	One conducted, others planned
Program Review	To be developed
SHRP - INTEGRAL PROGRAM	
Test Site Support	Under development
Visiting Researcher	Program in place
SHRP - TECHNOLOGY TRANSFER	
Pavements	To be developed
Structures	To be developed
Highway Operations	To be developed
Asphalts	To be developed
COMPLEMENTARY PROGRAM	
Pavements:	
VW&D Test Sites	Proposal solicited from Alberta Res. Coun.
Canadian LTPP	Program developed, 1988 launch
Bituminous Surface Treat	Program under development
Automated Distress Measur	Terms of Reference under development
Asphalts:	
A,B & C Asphalts - Lab	Terms of Reference under development
A,B & C Asphalts - Field	Terms of Reference under development
Highway Operations:	
Surface Defects	Project launched
Shoulder Ravelling	Project launched
Snowdrifting	Deferred until fall 1988
Snowdrifting - Expert Sys	To be developed
Deicing Chemicals	To be developed
Structures:	
Structure Repairs	Project launched
Bridge Evaluation	To be developed
Fibre Shotcrete	To be developed
Corrosion Resist. Repairs	To be developed

C-SHRP RESEARCH PROGRAM : Overall Schedule



Legend:

- o : Interim Report
- X : Major Report
- OOO : Completed Activity
- —— : Planned Activity
- * : Completed Event
- vvv : Development

Appendix A:

C-SHRP Committee Membership

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Appendix B:

Complementary Program:

Completed Terms of Reference

Terms of Reference:

Further Monitoring of Vehicle Weights and Dimensions Test Sites

C SHRP Complementary Program

Project A-1: Vehicle Weights and Dimensions Test Sites

1. Introduction and Problem Statement

Under the Vehicle Weights and Dimensions Study, different types of flexible pavement structures were tested to measure the relative damaging effects of a variety of truck axle loads and configurations. A committee of pavement engineers from each jurisdiction selected fourteen sites for the program, each being considered representative of a type of structure to be used in the 1990's. In 1984 a standard instrumentation package was installed at each site consisting of three strain carriers (to measure interfacial strain), three Linear Variable Differential Transducers (to measure surface deflection) and a thermocouple string (to measure temperatures of structure layers). Following installation of the instrumentation, each site was repaved and structural profiles and materials characterizations were documented in standardized formats.

In the summer of 1985, a standard test program was carried out at each site to measure the relative destructive effects of single, tandem and tridem axle configurations at varying load levels. By comparing the strain and/or deflection response relative to that caused by an 8180 kg single axle, Load Equivalency Factors were developed for each axle load and configuration at each test site.

The Vehicle Weights and Dimensions Study Pavement Test Program was the largest, most comprehensive, nationally coordinated pavement research investigation undertaken in Canada. Over $500,000 was invested in the program, almost half of which was incurred in preparation of sites and set up costs. Based on past experience in Alberta, there is a high probability that the instrumentation at most sites will remain functional for several years to come.

The opportunity therefore exists to conduct further testing and investigations at the remaining functional test sites to exploit the already significant past investment in establishing the testing capability and documenting the structure characteristics.

2. Objectives

The objectives of the program are as follows:

a. To examine the change in response of the structures to axle loadings over time, due to aging of the pavement and due to influences of regular traffic loadings.

b. To examine the influence of seasonal variations on the response of the pavement structure to axle loadings (eg. spring thaw, extreme cold and extreme heat)

c. To measure the relative destructive effects of truck axle loads and configurations not tested in the Vehicle Weights and Dimensions Study.

d. To examine the influence of different tire types and pressures on the response of pavements to axle loads.

3. Research Plan and Procedure:

The program will consist of a series of independent investigations addressing each of the objectives outlined above and structured to produce reports containing findings and structured data bases relevant to the specific objective.

PHASE 1: Program Initiation

TASK 1: Test Site Inventory

The available inventory of test sites will be reviewed to determine the suitability and viability of continued testing at each location. Sites will not be included in further monitoring or test programs if:

a. There are known problems with the instrumentation, installation or location which became apparent during the Vehicle Weights and Dimensions Study.

b. The structure has been rehabilitated or otherwise modified since the VW & D testing was completed.

c. The instrumentation is no longer functional. Field visits to the remaining candidate sites will be required in this task.

TASK 2 : Test Site Selection

It is expected that five to seven sites will remain available for consideration following the above review process. These sites will then all be used for long term monitoring and will constitute an available pool for selection of sites for the three specific research investigations which will be undertaken.

PHASE 2 MONITORING PROGRAM: Data Collection and Management Procedures - Long Term Monitoring

The data collection elements, procedures and protocol being developed for the SHRP integral program will be considered in the monitoring requirements of the selected VW & D sites, as will be the case for all other sites subject to long term monitoring. In addition, the following additional data requirements are proposed:

a. Seasonal monitoring of pavement response to normal traffic loadings:

Procedures:
Hardware is currently under development which is capable of on-site monitoring of peak strain and deflection induced by each axle load passing over the site. This data will provide a profile of the responses of the structure to the normal distribution of traffic loadings. It is proposed that this data be collected at each site for one week intervals four times per year. This will provide a means of observing the change in response of the structure due to seasonal influences and, as data for several years is accumulated, the influence on response of the aging of the structure will become evident.

To provide control and reference levels for the accumulated response profiles, special test sequences will be carried out twice a year at each site to measure strain and deflection under the standard loading of a single 8180 kg single axle. These tests will be carried out during the summer months when the structure is stable.

In keeping with the objectives of the long term monitoring tasks, it is proposed that the preceding performance and response data collection efforts be continued until the section requires rehabilitation, in the opinion of the host jurisdiction.

Products:
Annual reports, by site, on the past year's testing and monitoring, highlighting:

i. The historical record and trends observed in the strain and deflection response characteristic of the site under normal traffic loadings.
ii. The record of seasonal variation in pavement response over the past year.
iii. Correlation of the pavement response data base with the observed pavement performance data collected under the umbrella long term monitoring program. This would include correlation of the strain and deflection response control data (ie. 8180 kg load) with the strength test data (eg. Falling Weight Deflectometer, Dynaflect etc.).

Anticipated Benefits:
The VW & D test sites will serve to provide greater insight to the factors which will influence the performance of all sites examined under the long term monitoring program, thereby enhancing the knowledge gained through both the intergral and complementary programs. The performance observed at these sites can be correlated with observed variations in strain and deflection response.

Estimated Costs:
$70,000 First Year - $25,000 annual (based on five sites)

Estimated Schedule:
June 1987 - Program end

Special Investigation 1: Seasonal Response Variations

Objective:
The objective of this investigation is to document the change in response characteristics of flexible pavement structures due to seasonal variations. Specifically, the changes in the strength of the structure during the spring thaw period, during periods of extreme cold in the winter months and extreme heat in the summer months will be investigated.

It is anticipated that two sites will be selected from the pool of available VW & D test sites for this program.

Procedure:
Using a standard 8180 kg single axle loading, the strain and deflection response characteristics versus pavement temperature will be determined for each structure when the soil conditions are stable (ie. late spring to autumn period). It is expected that these relationships will change as the pavement structure ages, and annual recalibrations will be carried out during the span of the program.

Having established the general response characteristics of the structure using the above procedure, testing will then be carried out during the winter months to determine the change in strain and deflection response due to freezing of the component layers. During the spring thaw period, the strain and deflection response to an 8180 kg single axle load will be closely monitored to characterize the change in strength as the temperature of the component layers increases.

Products:
A report describing the procedures used, a synthesis of the data collected and a description of the key findings with respect to the changes in response characteristics of the structures tested due to seasonal influences.

Anticipated Benefits:
A better understanding of the influences of seasonal conditions on the response of flexible pavement structures which will provide a means of assessing the appropriateness of current seasonal variations in allowable vehicle weight limits.

Estimated Cost:
$50,000 (based on two sites)

Estimated Schedule:
June 1987 - January 1989

Special Investigation 2: Development of Load Equivalency Factors for Whole Vehicles and Special Axle Configurations

Background:
As a result of the implementation phases of the Vehicle Weights and Dimensions Study, specific vehicle configurations are emerging as candidates for interprovincial carriage. Past research and analysis has examined the relative damaging effects of single, tandem and tridem axle arrangements at varying load levels and interaxle spacings. However, to date it has been necessary to estimate the potential destructive effects of the actual vehicles in service by summing the load equivalency factors of each of the axle groups present on the vehicle.

Objectives:
Using the techniques developed in the Vehicle Weights and Dimensions Study, Load Equivalency Factors will be developed for selected heavy vehicle configurations by determining the total strain and total deflection caused by the vehicle. In addition, Load Equivalency Factors will be developed for the following:

a. Quad Axle Configurations
b. Special Off-highway Vehicles (eg. Earthmovers, Skidders)

Procedures:
Each of the selected test vehicle configurations will be run over the site at varying load levels, consistent with operational practice, and the pavement response relative to the 8180 kg single axle loading will be measured. Similarily, quad and five axle arrangements will be tested at varying load levels and vehicle speeds. The Load Equivalency Factors will then be determined for the vehicle by employing the relationship used in the VW & D Study.

Products:
A report descibing the findings, by site, with respect to the load equivalency factors calculated for each of the vehicle configurations examined, at each of the load levels tested, and the load equivalency factors determined for quad and five axle arrangements. The report will include a summary of the general conclusions reached and trends observed.

Anticipated Benefits:
A better understanding of the potential damaging effects of actual vehicle configurations in service and an improved procedure for estimating the cost implications of changes in the fleet mix of heavy vehicles using the highway system.

Estimated Cost:
$100,000 (based on five sites)

Estimated Schedule:
January 1988 - January 1989

Special Investigation 3: Tire Pressure Influences

Objectives:
The influence of tire pressure on pavement response has emerged as a pressing issue. The objectives of this investigation are:

a. To develop a pavement instrumentation procedure capable of measuring the influence of tire pressure on pavement response.

b. To determine the influence of tire pressure on the response of flexible pavement structures to normal dual tire axle loadings.

c. To determine the influence of tire pressure on the response of flexible pavement structures to wide based single tire axle loads.

Procedure:
In this investigation the response of each of the selected test structures to variations in tire pressure will be measured as follows:

a. A single axle loading of 9000 kg will be used as the basis for the testing.

b. Two tire types will be examined; standard 11R 22.5 dual tires (radials) and wide base radials (super singles).

c. Three tire pressures will be examined for each of the two tire types.

The response of the structure will be measured at each tire pressure level, for each tire type, thereby providing insight to the relationship between pavement response and tire pressure. If significant influences are observed, the influence of tire pressure on the Load Equivalency Factor for the axle will be determined.

Products:
A report documenting the test procedures used, and the findings obtained with respect to the two objectives (by site and in general).

Anticipated Benefits:
An insight to the influence of tire pressure on pavement response, and hence potential damaging effects, and an assessment of the need for regulatory control of this aspect of highway transport operations.

Estimated Cost:
$40,000 (based on two sites)

Estimated Schedule:
June 1987 - January 1988

Terms of Reference:

Canadian Long Term Pavement Performance Program

Terms of Reference

Long Term Pavement Performance

Research Program Design

1. Background

A major element of the U.S. Strategic Highway Research Program involves the long term monitoring of pavement performance over what will likely be a 15 to 20 year period. The design of the research program has been constructed to obtain insight to the influence of numerous factors on pavement performance, ranging from design and construction techniques and materials, to varying climatic conditions and traffic exposure levels. Canadian provinces have been invited to offer sites for possible inclusion in this program which meet the criteria that have been established by the designers of the investigation.

It has become apparent that many design or construction features, climatic conditions and traffic levels of interest to Canadian highway agencies do not meet the criteria which have been established for possible inclusion in the U.S. program. Further, it has become evident that the prospects of Canadian sites being included in the U.S. long term pavement performance monitoring investigation have been diminished due to logistic constraints faced in the U.S.

For these reasons, the C-SHRP Technical Steering Committee has commissioned an investigation to design a compatible research program which would address directly priority issues and concerns of Canadian highway agencies. This investigation will document the required scope, logistics implications and financial requirements of conducting an independent, yet compatible, program solely within Canada.

2. Objectives

A research investigation into the long term performance of pavement structures is needed to address Canadian research priorities and needs, while remaining compatible with, and reaping the benefits of, the U.S. long term pavement performance program. Specifically, the following objectives should be addressed:

(a) To identify and document specific issues, factors and concerns whose influence on long term pavement performance could be quantified.
(b) To design an experimental structure and framework which would provide statistically sound conclusions through a long term monitoring program, of issues identified in objective (a).
(c) To establish criteria for selecting sites for inclusion in the program.
(d) To define the required site information and ongoing data needs which should be collected and assembled for each test site. The information and data elements should be collected, assembled and managed through mechanisms which achieve compatibility with the information data base to be assembled from the U.S. program.

(e) To define the costs and responsibilities of conducting the program as designed.

3. Scope

To assist in this, the Technical Steering Committee of the C-SHRP program wishes to obtain the services of Dr. Tom Christison of the Alberta Research Council to participate in the study design in the following areas:

(a) To review the criteria used to develop the U.S. long term pavement performance monitoring program, including the data collection and information management system elements.
(b) To prepare a draft experimental design suited to the Canadian needs for review and discussion by representatives of all highway agencies in Canada. This experimental design should include, but not necessarily be limited to:
    - the overall program objectives
    - scope of the proposed program
    - criteria to be used in selecting sites for inclusion
    - identification of required site information and ongoing monitoring data elements
(c) Following consultation with highway agency representatives, and full discussion of the draft report, preparation of a final report outlining the program design, site selection criteria and proposed information and ongoing data needs.
(d) To provide assistance in soliciting candidate sites from highway agencies in Canada, and to assist in selecting sites which meet the identified criteria.

4. Deliverables

The research program design will be documented in reports on the following items:

(a) The final report on the experimental design, site selection criteria, information and data needs.
(b) Data collection manual for use by participating jurisdictions.
(c) A recommended division of responsibilities and estimated financial commitments to carry out the program as defined.

5. Schedule and Timing

The program design and its associated reports should be completed no later than October 31, 1987.

6. Budget

The Technical Steering Committee of the C-SHRP program has agreed to contribute up to $15,000 to obtain the professional services of Dr. Tom Christison of the Alberta Research Council to contribute to this effort.

Terms of Reference:

Bituminous Surface Treatments

Canadian Strategic Highway Research Program

Terms of Reference:

Research Program Development for Bituminous Surface Treatments

Background:

Bituminous surface treatments (BST's) are currently used by several jurisdictions as economical alternatives to asphalt concrete structures on low volume roads, particularly in Western Canada. In this context, there has been interest expressed in the development of generic design guidelines for BST structures for both normal and heavy traffic loading applications.

Other jurisdictions consider BST's to include the application of liquid asphalt emulsions as a means of sealing of asphalt concrete structures, either in staged construction, or as a means of rehabilitation of existing structures.

While there appears to a lack of consistency across the country in defining the term Bituminous Surface Treatment, and a range of practice in its use and application, there is considerable interest in the potential to develop a viable, economical alternative to asphalt concrete structures where conditions permit.

Objectives:

The Technical Steering Committee of C-SHRP has agreed to commission an investigation, to be carried out in consultation with the federal, provincial and territorial highway agencies, which will address the following objectives:

a. To define the term Bituminous Surface Treatment as it relates to current Canadian practice.

b. To document current Canadian practice in the design, use and application of BST's.

c. To identify the research needs and priorities in this area for consideration under the C-SHRP complementary program.

d. To design research program options capable of addressing the needs and priorities identified.

Procedures:

The principal investigator responsible for this initiative will be Mr. John Scott, in collaboration with Mr. Guy Dore of the C-SHRP Coordinator's Office.

Each of the sponsoring agencies of C-SHRP will be contacted in conducting the surveys of practice and in identifying the research needs and priorities. Where appropriate, meetings will be convened with representatives of those agencies with significant experience in the design, use and application of BST's.

Deliverables:

The preceding survey and investigation will be documented in a camera ready report structured in two volumes as follows:

Part 1: The survey of Canadian practice in the design, use and application of Bituminous Surface Treatments, including definition of the term.

Part 2: BST research needs and priorities and research program options

This report will be presented to the C-SHRP Technical Steering Committee on a date to be confirmed in the spring of 1988.

Terms of Reference:

Correction of Surface Defects in Flexible Pavements

TERMS OF REFERENCE FOR RESEARCH PROJECT

PROJECT TITLE:

Corrective Measures for Surface Defects in Flexible Pavements

PROJECT LEVEL OF SUPPORT:

$350,000.00 (total expenditure for all tasks)

GOAL OF THE PROJECT:

The goal of this project is to develop manuals which provide equipment specifications, material specifications and procedural guides for the maintenance of various types of surface defects or failures, in flexible pavements.

OBJECTIVES OF THE PROJECT:

The specific project objectives are:

1. to quantify the effectiveness of existing maintenance techniques from current literature and from undocumented empirical field procedures.
2. to identify existing or alternative maintenance practices and materials which warrant further testing and analysis.
3. to evaluate alternative maintenance procedures and materials.
4. to develop a cost-benefit framework to optimize maintenance practices.

PROBLEM BACKGROUND

Pavement surface repairs account for a large percentage of highway maintenance dollars spent annually throughout Canada. Pavement surface defects cause undesirable driving conditions and shorten pavement life. These defects result from thermal movement, freeze-thaw cycles, severe loadings, high truck counts, poor materials, poor construction practices, poor sub-grades, high tire pressures, etc.

The surface repairs include patching, sealing, grinding, partial overlays, milling and replacing, and other activities aimed at keeping the surface operational and avoiding premature deterioration.

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Many jurisdictions throughout Canada and abroad have documented studies and test results on these problems, however it is felt that there is a vast amount of information in the field which has not been documented. It will be the consultants responsibility to research all available literature and undocumented field information to determine if there exists a good basis for developing warrants and corrective measures, or whether further tests and analysis are required.

Equipment, material and procedural specifications are to be developed for a range of defect treatments. The cost-benefit relationships which need to be developed must be sensitive to regional variations in material and labour costs, across the Nation.

STUDY TIMING

The contract time for this project is 48 months, which includes one month for review of the interim report (task 7), two months for review of the final research report (task 11) and one month for review and revision of the manual(s) (task 12). Attendance by the contractor at the review meetings shall be included in the budget.

It is anticipated that a contract will be awarded by 1 January 1988.

STUDY SCOPE:

The project essentially consists of developing a compendium of maintenance failure mechanisms and appropriate remedial measures. There is however, the potential for including some innovative procedures and materials. The extent to which the project extends beyond current practices is limited by the available funds, and will be determined by the contractor's ability to acquire existing data. Although this project is aimed at corrective measures after failure has occurred, the project results may impact or reflect upon, design and initial-construction practices.

The surface defects within the scope of this project include the following:

1. PAVEMENT RUTTING - is permanent, longitudinal deformation of the pavement surface along the wheel paths.

2. THERMAL CRACKING - is generally transverse cracking in the pavement structure caused by temperature induced movements, rather than by loading.

3. FATIGUE CRACKING - refers to a group of cracking patterns caused by repeated loading or inadequate pavement structure.

4. BLEEDING - is a film of excess asphalt cement on the pavement surface which results in reduced skid resistance. Low air voids and excessive asphalt cement during original construction manifests bleeding.

5. POTHOLES - are localized holes in the pavement surface which form when traffic removes disintegrated material from a severely cracked area.

6. POLISHING - is a general smoothing of the surface due to high traffic volumes, and results in decreased skid resistance.

7. HEAVING - refers to swelling in the road surface caused by frost action in the subgrade.

8. DEPRESSION - is a localized lowering of the road surface caused by subgrade settlements.

9. CORRUGATIONS - are a series of small, transverse humps in the surface caused by insufficient cohesion in the surfacing to resist deformation under dynamic vehicle loading.

10. RAVELLING/WEATHERING - is a deterioration of the pavement surface, with ravelling referring to loss of aggregate and weathering referring to loss of binder.

11. SLIPPAGE CRACKS - are curvilinear cracks formed in areas of high braking or turning of vehicles, which cause the pavement layer to slide or deform on the underlying base.

12. RIDGING - is the formation of small humps at traverse cracks and is related to swelling in the subgrade.

It is envisaged that the project will include at least the following tasks:

Task 1. Prepare a detailed work plan designed to meet the project objectives.

Task 2. Identify the methods, equipment and materials utilized for remedying surface defects.

Task 3. Define the data elements to be collected for analyzing the effectiveness of various treatments.

Task 4. Develop a data base using available literature and undocumented empirical field procedures.

Task 5. Propose further data collection, if warranted, to be field gathered.

Task 6. Propose innovative methods or materials to be field tested and quantify the number of statistically significant sites required. (Any test sites to be established would be supplied by C-SHRP member agencies with the research project contractor being responsible for coordinating quality control and monitoring, but not for actual construction or material.)

Task 7. Prepare an interim report on tasks 1 through 6 not later than six months after the project commences. The report will provide alternatives for completion of the project using various combinations of existing information, newly collected field data and newly constructed test sections. The report will also describe the analyses of the data proposed to satisfy the project objectives. The interim report will be reviewed by the C-SHRP Technical Steering Committee who will give approval to proceed to the remaining tasks as outlined or in modified form.

Task 8. Collect the data approved as a result of the interim report (task 7).

Task 9. Analyze the data to identify the significant parameters and allow a prediction of the performance for each remedial action.

Task 10. Develop guidelines that detail:

(a) warrants for remedial action.
(b) procedures based upon type, cause and degree of defect.
(c) materials and equipment.
(d) any preventative actions identified during the project.

Task 11. Prepare a final research report.

Task 12. Prepare a manual for correcting defects in flexible pavements.

Task 13. Within twelve months of completion of the research project, at the direction of the C-SHRP Technical Steering Committee, make a presentation of the research findings at a suitable conference, forum or workshop in Canada.

In addition, quarterly progress reports will be required.

The intended audience for this work consists of the engineering and maintenance staff of the provincial and federal governments, municipalities, consulting engineers and maintenance contractors.

STUDY PRODUCTS:

The products of this project will be:

1. The identification of the most cost-effective materials, equipment and methods for correcting defects in flexible pavements.

2. A manual for selecting and applying the most suitable remedial action for a given surface defect.

Terms of Reference:

Removal of Hazards due to Ravelling of Granular Shoulder Material

TERMS OF REFERENCE FOR RESEARCH PROJECT

PROJECT TITLE:

Removal of Hazards Due to Ravelling of Granular Shoulder Material

PROJECT LEVEL OF EFFORT:

$130 000.00 (Total Expenditure for all tasks)

GOAL OF THE PROJECT:

The overall project goal is to evaluate the parameters that influence ravelling of granular shoulders at the pavement edge, to facilitate the development of cost effective shoulder treatments.

OBJECTIVES OF THE PROJECT:

The specific project objectives are:

1. to synthesize, from current practice and available literature, the state of the art in shoulder design
2. to determine the relationship between shoulder design standards and accidents
3. to determine and quantify the parameters which influence ravelling under a variety of geometric conditions, traffic volumes and vehicle mixes
4. to develop a cost-benefit framework for designing and constructing shoulder treatments

PROBLEM BACKGROUND

"Ravelling" is the removal of granular material from the inside edge of gravel shoulders adjacent to a paved lane. The ravelling is caused by the mechanical action of tires on vehicles which drift over the pavement edge, onto the gravel surface. Ravelling is also

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caused by wind turbulence generated by the passage of large vehicles (trucks) travelling at highway speeds. Ravelling causes a trough to form along the pavement edge which allows trapped run-off water to further aggravate the ravelled condition and contributes to pavement edge breakage and to shoulder deterioration.

The vertical drop created at the pavement edge under these conditions is hazardous to vehicles which drift over the pavement edge at highway speeds. Locations where vehicles are likely to drift over the pavement edge include curves and unchannelized intersections where vehicles stopped to turn constrain the through traffic. The greater vehicle width of trucks affects the lateral position of vehicles on the road surface, which increases the probability of vehicles drifting over the pavement edge, particularly on roads with high truck volumes.

A number of studies, in Canada and abroad, have documented isolated findings on shoulder treatment types and widths, and their relationship to accidents. It is perceived that there also exits a quantity of valuable knowledge and data in the field, which is not documented. It remains to be determined if these findings constitute a good basis for developing warrants for corrective strategies. If existing data is not sufficient, the need for and extent of a data collection program must be determined.

It is perceived that not every problem location is best remedied, from a cost-benefit point of view, by paving shoulders with one or two lifts of hot mix asphalt concrete to full shoulder width. At the same time, surface treatments for shoulders having lower capital costs may require high maintenance on higher volume highways. A cost-benefit framework must be developed to facilitate the selection of the optimum shoulder treatment design for particular geometric and traffic conditions. This analysis must include composite shoulder treatments.

The research must address whether corrective treatments should be applied only at the ravelled location, or if the treatment should be applied beyond the ravelled area to provide visual and operating consistency for motorists. Where consistency is not feasible, traffic management techniques to alert drivers to the changes in shoulder design, should be factored into the cost-benefit analysis.

STUDY TIMING:

The contract time for this project is 40 months which includes 1 month for the review of the interim report (task 6), two months for review of the final research report (task 9) and one month for review and revision of the manual (task 10). Attendance by the contractor at the review meetings shall be included in the budget.

If it is determined that the collection of field data is not necessary, the project duration would be significantly reduced and the project cost appropriately lower.

It is anticipated that a contract will be awarded by 1 January 1988.

STUDY SCOPE:

The contractor will synthesize and analyze undocumented knowledge, available literature and data for the purpose of developing cost-effective methods for applying shoulder treatments to eliminate ravelling. Monitoring of field sites to collect data to complement existing data may be required and will impact both the duration and budget of the project.

Although this project may impact the design of new shoulders, the scope is intended to be for the treatment of existing granular shoulders.

It is envisaged that the research will include at least the following tasks:

Task 1: Prepare a detailed work plan designed to meet the project objectives, including a detailed description of the intended analysis procedures.

Task 2: Conduct a state of the art review of the relationship of shoulder design to accident histories.

Task 3: Prepare a synthesis of cost-benefit evaluations of shoulder designs and treatments, which have been previously prepared by others.

Task 4: Identify the extent of empirical knowledge and historical data available from Canadian agencies, and evaluate the liklihood that these data alone could be used for the analyses.

Task 5: Define the extent, if any, of field data that must be collected to supplement the historical data, and identify the resources that would be required and the methods to be used for data collection.

Task 6: Prepare an interim report on tasks 1 through 5 not later than 8 months after the project commences. The report shall identify the data base to be used in the analysis and show how the data elements will be used in task 8. The interim report will be reviewed by the C-SHRP Technical Steering Committee who will give approval to proceed to the remaining tasks as outlined or in modified form.

Task 7: Collect the necessary data. (Any constructing, testing or monitoring of field sites for the purposes of supplementing existing data, would be performed by C-SHRP member agencies under the direction of the research project contractor.)

Task 8: Analyze the data to identify the parameters which cause ravelling and develop cost effective corrective strategies based upon a range of the identified parameters.

Task 9: Prepare a final research report.

Task 10: Prepare a manual of material and design specifications.

Task 11: Within 12 months of completion of the research project, at the direction of the C-SHRP Technical Steering Committee, make a presentation of the research findings at a suitable conference, forum or workshop in Canada.

In addition, quarterly progress reports will be required.

The intended audience for this work consists of the engineering staff of the federal and provincial governments, municipalities and consulting engineers involved in highway design, construction and maintenance.

STUDY PRODUCTS:

The products of this project will include:

1. A synthesis of the relationship between shoulder design and accidents.

2. A synthesis of existing shoulder treatment practices and existing cost-benefit studies of shoulder treatments.

3. The development of design guidelines for shoulder treatments under a variety of geometric conditions, traffic volumes and vehicles mixes.

4. Manuals which provide equipment and material specifications, and procedures for applying shoulder treatments.

Terms of Reference:

To Quantify the Service Life of Existing Canadian Methods of Rehabilitation of Decks, Beams, Piers and Abutments

TERMS OF REFERENCE FOR RESEARCH PROJECT

PROJECT TITLE:

To Quantify the Service Life of Existing Canadian Methods of Rehabilitating Concrete Decks, Beams, Piers and Abutments

PROJECT LEVEL OF EFFORT:

$300,000.00 (TOTAL EXPENDITURE FOR ALL TASKS)

GOAL OF THE PROJECT:

The overall project goal is to quantify the service lives of rehabilitation methods used on concrete bridge components, to permit a determination of the most cost-effective treatments.

OBJECTIVES OF THE PROJECT:

The specific project objectives are:

1. To identify those methods of rehabilitation best suited to the rehabilitation of different types of distress.
2. To determine those factors which have the most significant effect on service life and to quantify their effect.
3. To develop failure criteria and the methodology for estimating service life by extrapolating performance data to the failure conditions.

PROBLEM BACKGROUND:

During the 1970's, corrosion of embedded reinforcement in concrete contaminated by chloride ions from deicing chemicals and from exposure to a marine environment was determined to be a major cause of deterioration in concrete bridge components. As a result, many agencies initiated programmes for the rehabilitation of corrosion-damaged members using techniques such as the application of patches (sometimes with the addition of a sealer), membranes, overlays, shotcrete, and cathodic protection. While corrosion has been the most common cause of distress, structures have also required rehabilitation because of such deficiencies as inadequate resistance to freezing and thawing.

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To date, little performance data is available to enable an assessment of useful service life and economic benefits of the rehabilitation techniques most commonly used in Canada.

Among the factors which affect the service life of rehabilitation treatments are the macro and micro climate at the bridge site and the type of structure. Other factors, which are more difficult to quantify such as the condition of the structure at the time of rehabilitation, the amount of concrete removed prior to repair, and the quality of construction, also have a significant effect on service life. The identification of the most important variables, their interaction, and the net effect on service life is not fully understood or known. Since many different methods of rehabilitation have been in service in different parts of Canada for a number of years, there exists an opportunity for documenting and sharing those solutions to the problems of concrete bridge component deterioration, which have proven to be most effective.

STUDY TIMING:

The contract time for this project is 36 months which includes 1 month for the review of the interim report and 2 months for the final report review and revision. Attendance by the contractor at the review meetings shall be included in the budget.

It is anticipated that a contract will be awarded by 1 January 1988.

STUDY SCOPE:

The researcher will collect and analyze data from rehabilitated structures in order to predict the service life of the most common methods of rehabilitation used in Canada. The amount of data which can be collected is limited by the budget for the project and consequently, emphasis must be placed on data provided by others. The scope of the project is limited to treatments which are applied after the time of initial construction.

It is envisaged that the research will include at least the following tasks:

Task 1: Identify the methods of rehabilitating concrete bridge components most commonly used in Canada.

Task 2: Define data elements to be collected.

Task 3: Identify those agencies which are willing to contribute data useful to the project. Establish procedures for supplementing these data by field surveys.

Task 4: Prepare an interim report on Tasks 1, 2, and 3 not later than 8 months after the project commences. The report shall justify the selection of rehabilitation treatments to be investigated, the agencies providing data, and shall show how the data elements defined in Task 2 will be used in Task 7. The interim report will be reviewed by the C-SHRP Technical Steering Committee who will give approval to proceed to the remaining tasks as outlined or in modified form.

Task 5: Collect the data identified.

Task 6: Define criteria for failure of rehabilitation methods.

Task 7: Analyze data to identify those parameters having the greatest influence on service life and develop a method of predicting service life as a function of these parameters. The development of mathematical models may be necessary as part of this task.

Task 8: Prepare design and construction guidelines for the most cost-effective methods.

Task 9: Prepare a final report documenting the research findings.

Task 10: Within 12 months of completion of the research project, at the direction of the C-SHRP Technical Steering Committee, make a presentation of the research findings at a suitable conference, forum or workshop in Canada.

In addition, quarterly progress reports will be required.

The intended audience for this work consists of the engineering staff of the federal and provincial governments, the larger municipalities, and consulting engineers engaged in bridge rehabilitation.

The benefits from the project will be:

1. The ability to select the optimum method of rehabilitation for a particular structure from a knowledge of which treatments are technically feasible and the cost-effectiveness of each method.
2. Reduction in rehabilitation costs.
3. Improved bridge management practices.
4. Better understanding of the factors which determine the service life of rehabilitation treatments.

STUDY PRODUCTS:

The products of this project will be:

1. The identification of the most cost-effective methods of rehabilitating concrete bridge components.
2. Guidelines for the design and construction of the most effective methods.